Stream Crossing Upgrade Guide for NEPA Projects on the West Side of the Shasta-Trinity National Forest

Introduction

Stream crossings are often considered to be the weakest link in wildland road systems, and outdated design standards are likely to have the greatest adverse consequences (Weaver and others, 2015). Several decades ago, efficient delivery of road surface and ditch drainage to the nearest stream channel was a standard goal of road design. At that time, road infrastructure protection was the main concern, not downstream water quality or aquatic resources. Today, undersized or poorly designed culverts can be viewed as loaded guns that can fail during even moderate sized floods, costing both money to repair as well as severe environmental degradation downstream.

Stream crossings present some of the greatest challenges to road reconstruction, as well as the greatest opportunities for future erosion prevention, water quality protection, and aquatic habitat restoration. Several challenges can include the need for NEPA analysis before in-stream treatments can be implemented, as well as the often prohibitively high costs of treatments. However, properly upgraded stream crossings should have a significantly lower risk of failure, so the failures that do occur should happen less frequently and should be smaller in magnitude. Therefore, upgrading stream crossings should reduce long term maintenance requirements and costs.

The purpose of this guide is to provide general descriptions of stream crossing improvement methods that are used on the west side of the Shasta-Trinity National Forest to treat legacy sediment sites that require NEPA analysis.

Legacy sediment sites that are located outside of stream crossings generally do not require NEPA analysis to be treated and are not discussed in this document.

Common Stream Crossing Problems

Significant design flaws in older stream crossings include those that threaten to cause catastrophic road failures with significant downstream impacts, and those that contribute to persistent, chronic water quality pollution. Serious design problems for which updated design standards now exist include the following:

- Undersized culverts that aren’t designed to pass a 100-year flood peak flow, including sediment and debris (Figure 1).
- Culverts that are failing or that have suffered damage since installation.
- Culverts that are barriers to aquatic organism passage.
- Culverted stream crossings that have diversion potential, such that if the culvert plugs, streamflow will be diverted down the road and discharged onto unprotected hillsides or into other stream channels (Figure 1).
- Hydrologically connected roads and ditches that discharge runoff directly into streams (Figure 1).

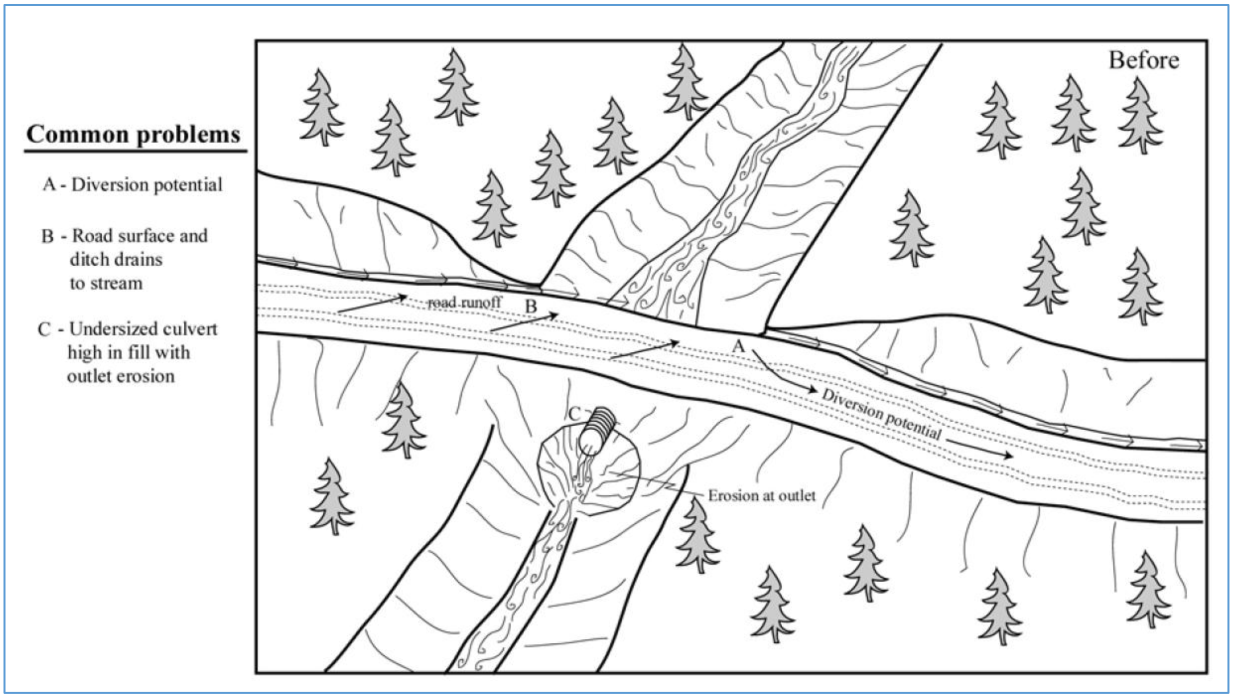

Figure 1. Stream crossing with undersized culvert and diversion potential (from Flosi and others, 2010). The undersized culvert (C) has caused erosion at the outlet. If the culvert plugs, water will pond behind the fill until it reaches point A where it will divert down the road. At point B, the road is not hydrologically disconnected from the stream, so road runoff flows directly into the stream.

General Description of Stream Crossing Treatments

Common legacy sediment site treatments in or near stream crossings can include the following:

- Upsize culverts to accommodate 100-year flood peak flows and associated debris (Figure 2).
- Attach flared inlets or construct mitered inlets on slightly undersized culverts (Figure 3). Mitered and flared inlets can increase the flow capacity as much as 50% compared to a typical projecting barrel inlet (Weaver and others, 2015).
- Construct critical dips[1] at culverted stream crossings (preferably at the down-road hinge line of the fill) to prevent stream diversion (Figure 2).
- Install rolling dips or ditch relief culverts[2] just up-road from stream crossings to hydrologically disconnect roads from streams (Figure 2).
- Install riprap at culvert inlets and outlets of stream crossings to dissipate energy and protect the base of the fill from erosion (Figure 4).

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[1] For extra protection, riprap armor may be placed at the outfall of the critical dip and extend downslope to the stream channel. This is suggested only for stream crossings where the culvert is highly likely to plug and the crossing fill overtopped.

[2] For extra protection, riprap armor may be placed at the outfall of the rolling dip or ditch relief culvert.

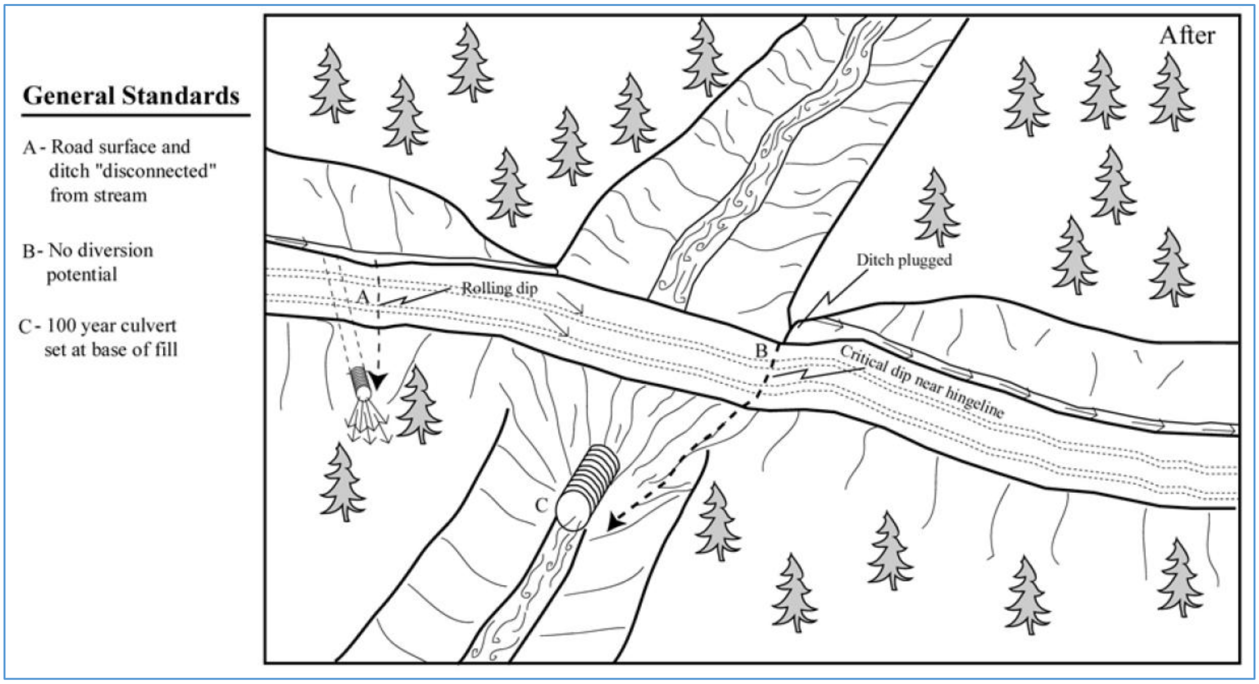

Figure 2. Upgraded stream crossing (from Flosi and others, 2010). The culvert (C) is now properly sized, which will greatly reduce erosion below the outlet. If the culvert inlet plugs, a critical dip (B) has been installed to allow water to flow directly back into the natural stream channel. A rolling dip (A) has been installed up-road of the stream crossing, which hydrologically disconnects the road from the stream crossing by diverting water into a vegetated buffer that can filter the runoff before it reaches the stream..

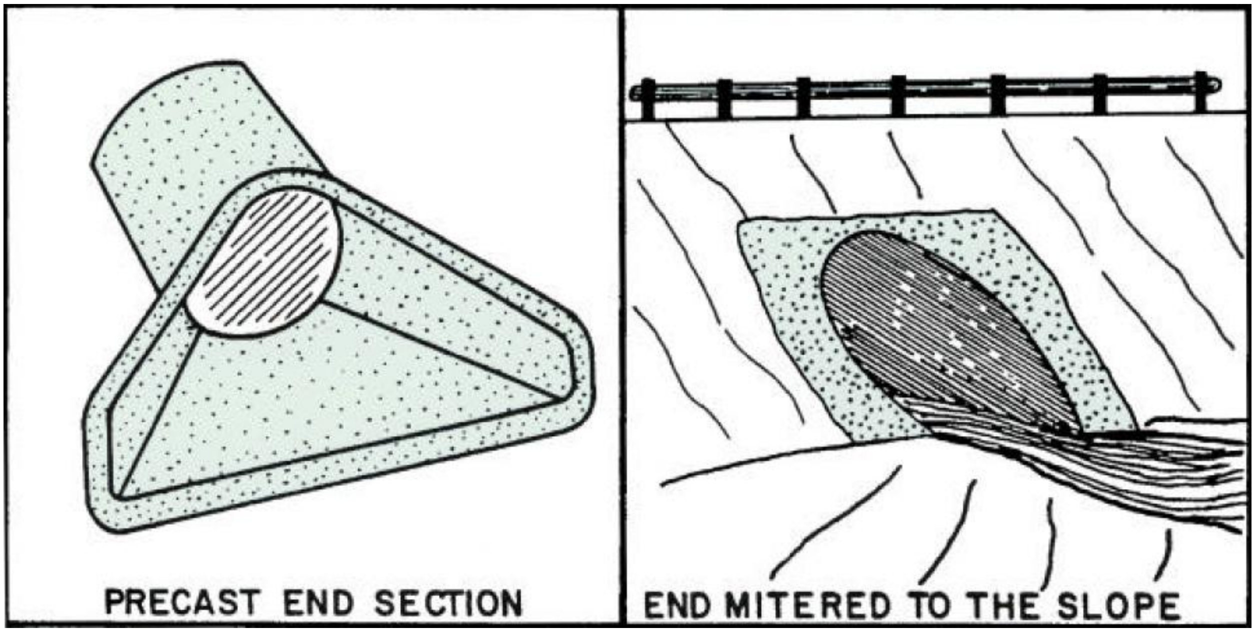

Figure 3. Precast flared inlet (left) and a mitered inlet (right) cut to match the slope of the embankment (from Flosi and others, 2010).

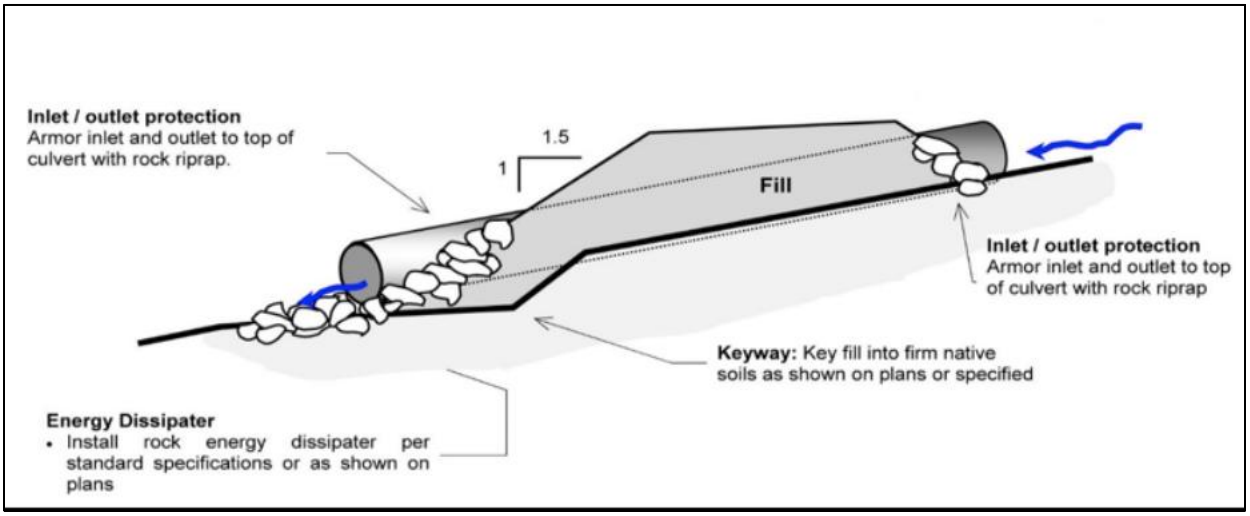

Figure 4. Riprap is used as inlet protection and outlet energy dissipation (from Weaver and others, 2015)

Prioritization

The Forest Plan contains guidance for prioritizing sediment sources (USDA Forest Service, 1995). Priority is to be given to watersheds with a degraded condition in a cost-effective manner and according to beneficial uses (Forest Plan, page 4-25). Key Watersheds that currently contain poor quality habitat are believed to have the best opportunity for successful restoration, and are to receive priority in any watershed restoration program (Forest Plan, page 4-59). Prioritization of road reconstruction activities is to be based on the potential impact and the ecological value of the riparian resources affected (Forest Plan, page 4-55).

Roads constructed on highly unstable geologic terranes have a much higher tendency to fail and deliver sediment to the stream system than those in other geologic formations; roads on the west side of the South Fork Trinity River main stem are relatively unstable and should be a first priority for remediation (U.S. EPA, 1998).

Guidance for prioritizing watershed restoration is available in the Watershed Condition Framework (USDA Forest Service, 2011). The forest supervisor needs to approve the selection of priority watersheds. The amount of NFS lands and the ability to effect a change in watershed condition are important considerations in the priority-setting process. Sub-watersheds in the best condition are to be selected for priority and restored first.

The following attributes for each legacy sediment site are assessed to determine priority of the treatment.

- Impaired watershed[3]
- Cost effective
- Key Watershed[4]

[3] The EPA and the State determine the impairment of watersheds. All of the watersheds in the South Fork Trinity River sub-basin are sediment impaired. Most of the watersheds in the Trinity River sub-basin are impaired for sediment; exceptions include New River and North Fork Trinity River, and portions of Burnt Ranch and Stuart Fork.

- Aquatic habitat[5]
- Critical coho habitat
- Unstable geologic terrane west of the main stem South Fork Trinity River (USEPA, 1998)
- Priority watershed (USDA Forest Service, 2011)
- Land ownership
- Watershed condition[6]

For each legacy sediment site, each of these attributes are assigned a value of zero or one. Sites that are within sub-watersheds that are sediment impaired are assigned a score of one. Sites with a lower than average cost to repair are assigned a score of one. Legacy sediment sites that are located within a Key Watershed receive a score of one. Sites in sub-watersheds with aquatic habitat in poor condition are assigned a score of one. Legacy sediment sites located in sub-watersheds with greater than average density of coho habitat[7] (miles of critical coho habitat stream per square miles of sub-watershed) are assigned a score of one. Sites located in highly unstable geologic terrane west of the South Fork Trinity River main stem are assigned a score of one. Sites that are located in a priority sub-watershed receive a score of one. Sites located in sub-watersheds that are more than 90 percent owned by the Forest Service are assigned a score of one. Legacy sediment sites located in sub-watersheds that are identified as functioning properly based on the 2011 Watershed Condition Framework are assigned a score of one. The sum of the attributes for each sediment source is a prioritization score ranging from zero to nine. After each sediment source is scored within the project area, the sites with the highest scores are assigned a priority of high, the middle a priority of moderate, and the bottom a priority of low.

Design and Implementation Techniques

Treatment alternatives should be discussed with the NEPA interdisciplinary team and developed from analysis of hydrologic conditions; the presence of endangered, threatened, and/or sensitive species; and the presence of cultural heritage sites.

Design

Before the NEPA decision is signed, the approximate geographic limits of area(s) to be cleared will be delineated.

Best management practices for planning activities in streams and Riparian Reserves include the following:

- Clearly delineate the work zone.
- Locate access and staging areas near the work site but outside of work area boundaries and riparian reserves.
- Develop an erosion and sediment control plan that covers all disturbed areas, including the work zone, and stockpile, fueling, and staging areas.

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[4] The Forest Plan (1995) identified Upper South Fork Trinity River, New River, North Fork Trinity River, and Canyon Creek as Key Watersheds.

[5] Aquatic habitat condition is described in the Watershed Condition Framework (USDA Forest Service, 2011).

[6] Watershed condition is identified in the Watershed Condition Framework (USDA Forest Service, 2011) as functioning properly, functioning at risk, or impaired function.

[7] Coho habitat densities range from 0 to 0.639 miles of stream per square mile of sub-watershed. The average density is 0.320/mile.

- Develop a site vegetation plan using suitable species and techniques to revegetate the site after construction is completed.
- Schedule construction activities to avoid direct soil and water disturbance during periods when heavy precipitation and runoff are likely to occur.
- Plan for solid-waste disposal and worksite sanitation needs.
- Schedule in-stream activities to occur in a manner that will avoid or minimize adverse effects to aquatic species.
- A dewatering and sediment treatment plan will be developed before implementation. Plan requirements include the following:
    - Streamflow must be diverted around the site.
    - Stormflows must be handled, with backup pump(s) available on site.
    - Capture and remove sediment from water that seeps into the excavation, mixes with soil, and becomes turbid.
    - Protect fish by providing suitable screens on all pump intakes.
    - Provide for fish passage around the construction site where necessary.
    - Rewater the site by releasing any large pools of water dammed during construction slowly to avoid heating of downstream water.

Implementation

Best management practices that shall be implemented during construction activities include the following:

- Refuel and service equipment only in designated staging areas.
- Ensure that all equipment that is operated in or adjacent to the stream is clean of aquatic invasive species, as well as oil and grease, and is well maintained.
- Use vegetable oil or other biodegradable hydraulic oil for heavy equipment hydraulics wherever practicable when operating in or near water.
- Conduct operations during dry periods whenever practicable.
- Promptly install and maintain erosion control measures.
- Promptly install and maintain spill prevention and containment measures.
- Install sediment and stormwater controls before initiating ground disturbing activities to the extent practicable.
- Limit the amount of exposed or disturbed soil at any one time to the minimum necessary to complete construction activities.
- Limit operation of equipment when ground conditions could result in excessive rutting, soil puddling, or runoff of sediments directly into the stream.
- Install suitable stormwater and erosion control measures to stabilize disturbed areas before seasonal shutdown of project operations or when severe or successive storms are expected.
- Use small, low ground pressure equipment, and hand labor where practicable.
- Maintain erosion and stormwater controls as necessary to ensure proper and effective functioning.
    - Prepare for unexpected failures of erosion control measures.

  - Implement corrective actions without delay when failures are discovered to prevent pollutant discharge into the stream.
- Routinely inspect the work site to verify that erosion and stormwater controls are implemented and functioning as designed, and are appropriately maintained.
- Use suitable measures to prevent and control invasive species.
- Stockpile and protect topsoil for reuse in site revegetation.
- Keep excavated materials out of the stream.
- Promptly compact fill to avoid or minimize erosion.
- Remove aquatic organisms from the construction area before dewatering, and prevent organisms from returning to the site during construction.
- Restore flows to their natural stream course as soon as practicable after construction or before seasonal closures.

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